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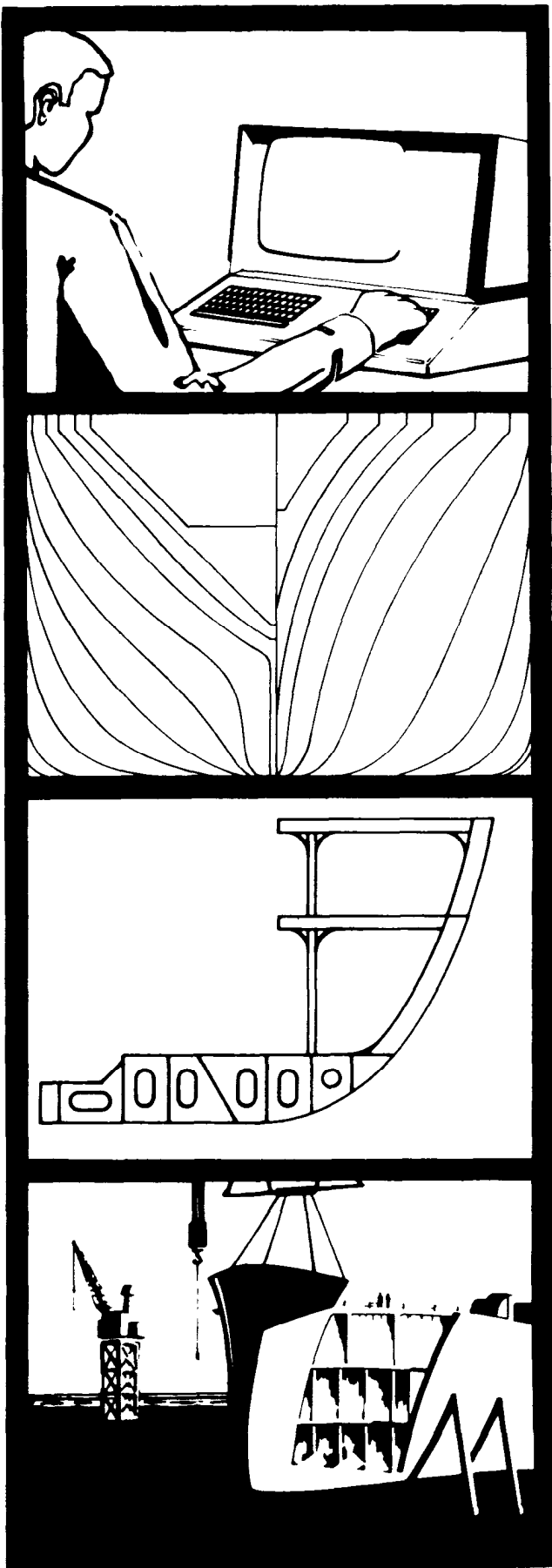
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**IMPROVING SHIPBUILDING PRODUCTIVITY
THROUGH INDUSTRIAL ENGINEERING**

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Provisions of the Merchant Marine Act of 1970 charged the Secretary of Commerce with the responsibility to "collaborate with ... shipbuilders in developing plans for the economical construction of vessels." To accomplish this task, the National Shipbuilding Research Program was established by the Maritime Administration with the responsibility to develop improved technical information and procedures for use by U.S. Shipyards, with the objective of reducing the cost and time for building ships. The Ship Production Committee challenged the industry to (1) develop the role of Industrial Engineering in shipbuilding; (2) implement an improved Industrial Engineering capacity; and (3) assist the U.S. shipyards in formulating standards for shipbuilding.

The introduction of Industrial Engineering to shipbuilding or the expansion of the role of Industrial Engineering in shipbuilding continues to the elevation of the level of technology in this industry. There are direct, demonstrable, traceable connections in the progression from high technology to productivity to profitability. This is an economic fact of life which causes some industries to thrive and others to languish or die.

Writing from London, The Economist made the point quite clear recently when it said, "The best job prospects are in those industries that improve productivity fastest. In Britain, the 10 industries that have increased productivity fastest in the past two decades have raised **employment** by 25%, although employment in British manufacturing as a whole has fallen. 'In the United States, high-technology industries have increased productivity twice as

fast as low-technology ones-and expanded employment nine times as fast. Unions should be asking employers to increase productivity faster, not slower."

The Economist adds, "The people who really are threatening to plunge rich countries into mass unemployment are those who try to shelter dying jobs in sunset industries, and thereby blight the prospects of growth of good jobs in sunrise ones. This includes all Luddite trade unions and politicians, most of the subsidizers of lame ducks, most advocates of import controls."

The need for a strong research and development program in shipbuilding is clear, Our goal is to increase productivity in shipbuilding. Industrial Engineers are dedicated to achieving productivity improvements. The Industrial Engineer integrates the technologies of shipyard operations into an efficient production system to allow us to (A) acquire the desired number of contracts to achieve marketing objectives, (B) to provide ships at a cost which meets or exceeds all profit targets, and (C) to meet all quality and delivery time targets. Satisfying these goals would provide the customer with a dependable product, delivered on time, and at a fair price, while providing a fair return to the shipyard.

To better understand the contributions which the profession of Industrial Engineering could make to increasing shipbuilding productivity, first let us define Industrial Engineering. "Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, material, equipment, and energy, It draws upon specialized knowledge and skills in the mathematical, physical, and social sciences together with principles and methods of engineering analysis and design to specify, predict, and evaluate the results obtained from such systems," (AIIE). Working with these systems, it is the objective of industrial engineering to achieve the goals and objectives of management. Industrial Engineering then advances technology through people,

To demonstrate that the application of Industrial Engineering technology could increase shipyard productivity, it was decided that the

initial effort would be directed toward studying work methods and establishing engineered job standards. Six yards were chosen as demonstration sites to develop job standards for particular areas of work. Not only would these six pilot projects test the impact of introducing job standards, but they would also provide standards information to all yards. Everyone could benefit without costly duplication of effort.

The purpose of establishing job standards is fourfold: (1) to develop the lowest cost system or method to perform the work; (2) to standardize the system or method to produce reliable forecasts of future costs and a valid basis for cost control; (3) to determine the time required by a qualified and properly trained person, working at a normal pace to do a specific task or operation; and (4) to assist and train the worker in performing the specified task using the preferred method. Standards *can* be used to set prices, plan production, and estimate capacity and manpower needs. Consequently, work standards should be a foundation for the entire shipbuilding operation.

A response I often hear when recommending the establishment of job standards is "putting in job standards is a waste of money. My people know how to do their job!" Right: Everyone knows how to make up a bed, wash a sink and vacuum a floor, but the Holiday Inn Southeast in Nashville saved a net of \$100,000 per year by studying the maids' job and putting in improved methods and standards. As *the* manager said "It wasn't the guests wearing out our carpets, it was the maids." From a level of 13 to 14 rooms/day, each maid now cleans 20 to 22 rooms/day and has extra time to check on and initiate needed room maintenance. This is a result of improved methods and establishing standards.

I.K.D. Corp., a metal fabricator, increased productivity 48% through engineering methods. Their industrial engineers studied a job which had not changed in 7 years. They made a change to fluxcore welding from stickwelding equipment and changed the work place layout. A 35% increase in productivity was accomplished through work measurements and setting standards on the same operation.

Likewise, in shipbuilding there have already been significant

improvements in productivity just as a side benefit of the methods and labor standards development program.

- 25 to 30% productivity improvement in crane utilization from the use of time studies to identify delays. As a result, more emphasis was placed on planning the crane moves and the riggers were prompted to be better prepared and set up for each crane usage,
- 10 to 40% productivity improvement in the shipboard assembly and installation area, resulting from a methods analysis performed while defining the process used in work measurement. Using the most efficient process also established proper manning requirements and a better definition of material requirements, palletizing, and staging needs.
- 15% productivity improvements were realized in the foundation assembly area. Some examples of methods improvements contributing to this overall productivity improvement rate are:

Installation of jib cranes to service work tables to eliminate the delays caused by using the bridge crane.

Setting up a clipboard logging system for fabricated parts replacing random storage, thus improving the flow of parts to the assembly work area.

Method change in fabrication of deck beam cutouts from burning to more efficient punching out of cutouts with a punch press. This process also reduces slag grinding time at assembly.

Switching from stick welding to more efficient fluxcore welding with the introduction of new fluxcore equipment.

Relocation of various equipment and work benches to allow a better flow of material.

These are conservative estimates from actual shipyard documentation. With the introduction of a cost reporting system and the use of the MOST Computer System during Phase II of this program, much greater returns are anticipated within the shipbuilding industry in the following years through the use of these computerized standards to support activities in welding, production scheduling and tither shipbuilding functions, Work standards are not required to do a job. Work standards are only required if the objective is to do a job better, at a lower cost.

If you aren't taking advantage of the labor standards program, you are missing a critical bet. The application of industrial engineering techniques can save significant dollars., as the improvements in the six yards using MOST have already demonstrated. More emphasis in the future will be placed upon applying job standards to a wider range of activities. Stress will be placed upon establishing consistent and accurate job standards to previously unstandardized functions. An example of this is Florida Power & Light now has 85% of its non-supervisory jobs under standards. \$900,000/year net audited savings has been realized by applying standards to clerical, service, and maintenance jobs. The Air Force's insistence on implementing Military Standard 1567 stated job standards will be set for more clerical and white-collar tasks, as the cost of these tasks rise in proportion to direct labor costs of manufacturing.

The impact of the development of methods and standards through Mil Std 1567 has already been demonstrated. This past week Boeing reported an increase of 20% in 2 years in one shop alone. They have already **achieved a gross savings of \$31.3m for an implementation cost of \$1.8m.** Boeing executives estimate a discounted return on their investment over the life of the project to be \$17. for each \$1 invested. Needless to say, they are quite pleased with the, program.

The results to date of the Mil Std 1567 remind me of the mother who forces her child to eat a balanced diet. While the objections to these directives maybe long and loud, the benefits are real and the good habits stay with the individual for a lifetime.

Work measurements, and methods engineering is the cornerstone of industrial, engineering activities and will have the highest immediate payoff of all industrial engineering functions to shipbuilding. These techniques provide the data for (1) preparing bids, (2) improving methods to increase productivity and, lower costs, and (3) monitoring and controlling the production operations.

The work measurement system is critical to the operation of all other functions. However, WMME. is not the only IE function. In the remainder of this presentation I would like to provide you with an overview of typical savings which have been achieved in, other industries through the expanded, application of other Industrial Engineering functions.

Just as in the application of work measurements and methods engineering, significant savings, are available through improvements in the material flow system. By redesigning their material flow system for one operation at I.K.D. Corp., the industrial engineers were able to increase productivity in that operation by 101% in 1979. This item was a low volume, heavy metal fabrication which was moved on large carts between various cutting, welding, assembling and finishing areas. The carts were actually used more for storage than for transportation. The result was crowded, poorly organized work places., The operators spent a very large percentage of their working day looking for, and moving materials. The industrial engineers flow charted this operation, analyzed it, prepared templates and layed out the work place. They achieved a better. operation and developed a place for all materials required in the process. Under the original layout an average of,, 1.4 man-hours were required. By the 5th week, it took 69 man-hours. Then by taking time studies, a final standard. of 0.67 man-hours/unit was developed. The standard was attained; because of the more efficient, layout, a six-fold increase in capacity was also possible in-the same floor, space allowing the cancellation of a p r o p o s e d s h o p e x p a n s i o n .

The industrial engineer has improved both the design and management of material handling systems for more efficient materials flow. For example, Maytag was able to reduce the initial cost of a proposed material

handling system for sheet metal by 23% (\$3.2 million) through a computer simulation of material flow. This simulation showed that by careful material management, 23% of the proposed material handling equipment was unnecessary.

Black and Decker was concerned with one aspect of their production control system stored parts availability. They had the following objectives:

- Reduce overall operating -cost

- Reduce clerical efforts in records and audits

- Provide data on current material availability status, and make these data available throughout the plant

Their industrial engineers took this \$14 million inventory and developed a computerized control system which

- Increased storeroom labor productivity 15%

- Increased space utilization

- Reduced "Balance on Hand" discrepancies from 3000 to an average of 100

- Cut lead time of material in the staging area from 3 weeks to 1 week.

- Increased expeditures response to manufacturing needs, and

- Reduced expediting of material obsoleted by engineering change orders.

They wanted to plan and sequence material where and when it was needed for the assembly operation.

Florida Power and Light saved \$13.5 million annually in inventory carrying Costs by using a computerized "what-if" model to test an idea from an Industrial Engineer. This idea used a central stores warehouse and control system for the 20,000 items in their 53 distribution centers. By better control they increased inventory turns by 300% (0.86 to 3.5) and reduced the value of the inventory they would have to carry by 48%. They also eliminated the need for rented space.

Scheduling control of the machine shop proposed by an Industrial Engineering organization in one of our shipyards recently would result in a payback of less than a year for all of the-computer hardware and

software necessary to implement the proposed scheduling procedure.

Forklift trucks are a neglected million dollar resource, at least in terms of replacement value. IBM at San Jose had 50 and were planning to expand to 100; yet, had no record of departmental utilization. The only truck records were the oil stained logs kept by the mechanics. - With maintenance costs less than 0.4% of the operating budget, these trucks got little management attention until someone wanted to spend \$25,000 'for a new truck,.

Justification data just wasn't available.' Every competing manager then became a truck expert. The result was one more welding job to patch up the old forklift until it fell apart. Then, upon final failure, emergency funds were used to buy a new one from the dealer's stock, one which probably didn't have all the features which were needed. Consequently, the old truck was probably resurrected and used as a "high-cost" spare.

The dealer won. The foreman, driver, and company lost. IBM realized a 30% annualized cost reduction in fork lifts after their industrial engineers initiated a cost collection system and a program of replacement analysis. These cost savings resulted from;

- (1) Reduction in total number of trucks through-better utilization (also they now have never and better trucks),
- (2) Replacement of old high maintenance trucks
- (3) Preventive maintenance program based on usage
- (4) Inventory system for spare parts, and

Adequate maintenance facilities to test the feasibility of this proposed system.

Bethlehem Steel recently used a simulation model to determine their equipment requirements and material flow in their Lackawanna Plant Billet Yard. They considered items in the model such as:

Equipment	Capacity
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Facility Layout

Crane Utilization

Travel Distance
Interference Measures
Queue Statistics
Resource Utilization
Down Time Statistics

Fortunately, an extensive base of standard data for methods and times were available for the various operations in the proposed facility. Consequently, an accurate and effective analysis of the operation of the proposed Billet yard was possible.

The model showed that the target capacity of the yard couldn't be achieved because of the bottleneck of grinder capacity. However if they were eliminated, capacity would still be limited below target by crane availability.

The Billet yard was then completely redesigned and is now operating successfully. The cost of the simulation was trivial compared to the cost of either missing production output targets or of reworking an installed facility, Bethlehem is now using this model to design its Johnstown Plant.

R. & G. Sloane, a California manufacturer of pipe fittings, built their production information system to schedule material arrival and control inventory. They increased inventory turns 25% and raised the on-time delivery schedule by 10% to 94% of total shipments. By building a management information system for the firm from their original production information system and by using it to analyze the most profitable profit mix, they added \$500,000 to net profits in 1978. However, be advised that they had to wait 6 months to use their computerized MRP Scheduling program because they didn't have good data in the systems

International Paper has gotten back \$100 for every \$1 invested in their system over a 5 year period.

Again, you must develop the cost data through job standards and cost accounting, build the model, and use 'it to ask "Whht if" questions to support managerial decision-making. To provide these data firms are computerizing their predetermined time standards for a comprehensive

data base of task related information. Baxter Travenol Labs saves \$800,000/year after-computerizing their -data base in 1978. The introduction of computerized MOST in Phase II will give the shipyards the opportunity to develop simulation models and ask these "What If" questions. The effort should be worth it in the profits derived from better decisions.

This set of examples was intended to illustrate the impact the application of Industrial Engineering techniques could have upon the productivity and profitability of the firm. Shipyards should be able to achieve at least these savings by going- into an organized program to implement Industrial Engineering techniques into their operations. Work measurements and methods engineering activities are just a first step, albeit an important one. The Industrial Engineer is involved in a multitude of functions, entailing a knowledge of both the technical and human side of the operation, It is this combination of technical and human functions which will put us on target for productivity.

What should the I.E. deliver? The Delco Division of General Motors charges each industrial engineer to submit and implement at least \$50,000 of direct cost reduction items per year. DuPont requires each industrial engineer to propose cost savings equal to 10 times his salary. Given this potential the combined effect on productivity improvement through the sound application of the techniques found in both the technical and human functions can provide an ever improving productivity and profitability for our shipyards. The potential is there, we only have to exploit the potential.

To achieve the desired objectives, it is necessary to have both "motivation and movement." These can be developed through establishing an operating industrial engineering organization. You must have this industrial capability "in-house."

It is important to "hit home runs" by picking projects with the greatest payoff. Gaining momentum from initial successes is critical. A prime example of home run potential is the current effort to establish job standards. Productivity increases of 10% to 40% should provide

that initial momentum and demonstrate the savings possible through the application of industrial engineering techniques. Further, job standards provide the base data for utilizing the other function of industrial engineering. Shipyards will reap future savings through using those standards, for example, in MRP production scheduling and computerized simulation and decision models. Consequently, those yards now establishing standards should be planning for their next "great leap forward," using their standards as a base for the application of other industrial engineering functions. The industrial engineer through leadership, reinforced with a positive attitude, can contribute significantly to effectiveness and profitability in shipbuilding.

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